Contents lists available at www.innovativejournal.in

JOURNAL OF BUSINESS MANAGEMENT AND ECONOMICS

Homepage: http://innovativejournal.in/jbme/index.php/jbme

ISSN: 2347-5471

A New Transparent Way to Perform Competition, Market Structure and IPR Portfolio Analyses: Analysis of the Dynamics of Trademark Competition in Finland as a Case Example

Theresa Lauraéus[1]& Jari Kaivo-oja[2]

[1] Aalto University, School of Economics, Helsinki, theresa.lauraeus@aalto.fi, +358403538296, Runeberginkatu 22-24, 00076 AALTO, FINLAND
[2]Finland Futures Research Centre, Turku School of Economics, University of Turku, jari.kaivo-oja@utu.fi, +358-2 -333 9837, Rehtorinpellonkatu 3,20014 TURUN YLIOPISTO, FI 20014 TURKU, FINLAND

DOI: http://dx.doi.org/10.15520/jbme.2017.vol5.iss12.276.pp08-23

Abstract: The paper presents a new way to perform IPR portfolio analyses (trademark and patent analyses) and other market structure analyses. Trademark and patents analyses become more significant for the development of companies, especially in current conditions of technological disruption. We will reflect (1) current STI management and foresight, (2) most important IT technology trends for year 2017 and (3) the most evaluated technologies in the Gartner HC evaluations. Trademark analyses and especially novel LKI analysis can contribute to capturing relevant aspects of market and technology disruptions. Our demonstration is focused on trade marking and trademark registrations in Finland. The LKI analysis is scientifically as generic as Herfindahl-Hirchman Index (HHI) has been during its long history of indicator research. LKI approach makes us free from the scaling problems of conventional HHI. IPR portfolios with any size can now be analysed without potential statistical biases. We develop and introduce the HHI index and a new IPR and market analysis index: LKI (Lauraeus-Kaivo-oja Index). The evaluation results of the HHI analysis and the LKI analysis are compared. With the LKI, we are able to compare better the substance of Intellectual Property Right (IPR) portfolios and market structures. Furthermore, we show, why percentage numbers are easier to comprehend than HHI index points.

Keywords: IPR portfolio evaluation; Trademark portfolio analysis; Patent portfolio analysis; STI management; Trend analysis of market structure; Innovation policy; the Herfindahl–Hirschman Index analysis (the HHI analysis); the Lauraeus-Kaivo-oja Index analysis (LKIanalysis)

INTRODUCTION

In the field of market analyses, the Herfindahl–Hirschman Index has conventionally been used in many market and IPR portfolio analyses. The value of companies in knowledge intensive activities is determined by the value of its Intellectual Property (IP). This paper introduces an alternative and novel way to make market and portfolio analyses. The novel Laureaus-Kaivo-ojaIndex(LKI) can also be applied in similar ways to how the Herfindahl–Hirschman Index has been used in various empirical market structure studies.

This paper is organised as follows:

Firstly, the introduction section (Chapter 2) briefly discusses the history of trademarks and trademark definition. We underline the strategic importance of trademarks in the field of IPR management. The novel LKI provides anew analysis and evaluation method to perform trademark portfolio analysis. We will study the McKinsey´s 12 potential technologies (McKinsey 2013).We focus on technologies that we believe to have significant potential to drive economic impact, and thus need for patents and trademarks. Further, we will investigate and reflect the current Gartner´s hype curve and the most important technological trends for year 2017. Finally, we will tell, why are trademark-based indicators important for technological innovations and management?

Secondly, the theoretical chapter (Chapter 3) discusses trademark-based indicators, and what the trademark issue means and how it should be understood from an economic perspective. In this theoretical chapter, we will introduce the Herfindahl–Hirschman Index (HHI index) and based on that, we will develop a novel trademark-based indicator for the LKI. Furthermore, the second section addresses the conceptual and analytical issues that arise when we consider trademarks as an innovation indicator and a tool for assessing structural transformation in domestic or international markets.

Thirdly, in this study, we base our empirical analyses on the international classification and statistical database of the Finnish Patent and Registration Office (2017). In Finland, the classification of trademarks has 34 classes of goods, and 11 classes of services. In the empirical demonstration (Chapter 4), we will analyse the dynamics of trademark competition in Finland based on the number of Finnish and international registrations from 2000-2015 by the full category data of 45 sectors with the HHI index, LKI and linear LKI index. This chapter is an empirical demonstration of how we can use the LKI in the field of trademark analysis. The case study data is from Finland. The LKI approach is useful in patent and trademark analyses.

Fourthly, in the final comparative evaluation (Chapter 5), we will compare the empirical results of trademark analyses by the HHI index and by the LKI together and draw final conclusions.

Fifthly, in summary chapter 6, a summary of key findings will be presented.

THEORY

The history of trademarks and a trademark definition:

Trademarks already existed in the ancient world. Even at times when people either prepared what they needed themselves or, more usually, acquired it from local craftsmen, there were already creative entrepreneurs who marketed their goods beyond their localities and sometimes over considerable distances. As long as 3,000 years ago, Indian craftsmen used to engrave their signatures onto their artistic creations. Manufacturers from China sold goods bearing their marks in the Mediterranean area over 2,000 years ago and a thousand different Roman pottery marks were in use (see McClure 1996, WIPO handbook 2004, Da Silva Lopes, Duguid 2010).

The first international trademark settlement was reached at the Paris Convention of 1883, whereby the countries involved agreed to provide foreign applicants with the same protection regarding marks as was given to nationals. In this context, the WIPO eventually emerged as the global coordinating institution promoting the development of IPR laws and facilitating the international registration of trademarks. The Paris Convention, which concluded in 1883, was revised at Brussels in 1900, at Washington in 1911, at The Hague in 1925, at London in 1934, at Lisbon in 1958 and at Stockholm in 1967, and was amended in 1979. (WIPO 2016, 2017).

According to the World Intellectual Property Organisation (WIPO), a trademark is defined as a "*distinctive sign, which identifies certain goods or services as those provided by a specific person or enterprise*"(WIPO 2016, 2017). Like patents, a trademark affords the owner legal protection by granting the exclusive right to use it to identify goods or services, or to licence its use to another entity in return for payment. Rights are granted at the national level, but once trademarks are registered, they can be renewed indefinitely on payment of additional fees (see WIPO 2016).

The business of branding products has long been part of ordinary economic life. Trademarks are the outcome of establishing recognisable designs and symbols for technologies, goods and services, as well as firms' identities. They play a crucial role in the process of marketing innovations, being instrumental in differentiating between the attributes of goods and services in the marketplace. These characteristics make trademarks a potential indicator of product innovation and sectoral change (see e.g. Mendonca, Pereira, Godinho2004). Trademarks are often used to analyse technical and commercial business competences of countries. A trademark is a sign capable of distinguishing between the goods or services of one enterprise from those of other enterprises (Mendonca, Pereira, Godinho2004, Hidalgo, Gabaly 2013). Patents and trademarks are also used as barriers to entry into markets (see e.g. Demsetz 1982). This aspect of market entry is relevant in the global competition. The unique character of technology, products and services is a key issue and a considerable market value in global markets(Kaivo-oja, Lauraeus 2017a, 2017b, 2017c, Kaivo-oja 2016).

Mendonca, Pereira and Godinho (2004) argued that trademark-based indicators provide a partial measure of the technological innovation output of profitoriented organisations. In its most simple formulation, innovation can be understood as the introduction into the market of a new idea, product or production process (Mendonca, Pereira, Godinho 2004).

The innovative and disruptive technologies having primary economic impact, and thus significance for patents and trademarks:

In this chapter, we focus on technologies that we believe have significant potential to drive economic impact and disruption by 2025. An *economically innovative and disruptive technology* must have the potential to create massive economic impact. The value at stake must be large in terms of profit pools that might be disrupted. Technologies that matter have the potential to dramatically change the status quo in markets and networks. They can transform how people live and work, create new opportunities or shift surplus for businesses, and drive growth or change comparative advantage for nations (McKinsey Global Institute 2013). Thus, regarding competition, there are significant role for patents and trademarks. Next, we present the McKinsey´s twelve potentially economically disruptive technologies (table E1) and (table E6) how they primary affect society, businesses and economies (McKinsey Global Institute 2013).

Important technologies can come in any field or emerge from any scientific discipline, but they share four characteristics: high rate of technology change, broad potential scope of impact, large economic value that could be affected, and substantial potential for disruptive economic impact. (McKinsey Global Institute 2013). Because technological innovations large economic value, the trademarks and patents are significant and veryimportant for the companies.

Innovation is always linked with developments InTechnology, science, economy and society. In scientific literature, innovation is often mentioned as one of the key drivers of economic growth, primarily in the sense of raising the level of education, infrastructure, health, the environment, and welfare (see Kuhlmann 2001, Kaivo-oja, Santonen 2016).

Disruptive technologies:

To be economically disruptive, a technology must have broad reach—touching companies and industries and affecting (or giving rise to) a wide range of machines, products, or services, and thus patents and trademarks. The technology is rapidly advancing or experiencing breakthroughs. *Disruptive technologies* typically demonstrate a rapid rate of change in capabilities in terms of price/performance relative to substitutes and alternative approaches, or they experience breakthroughs that drive accelerated rates of change or discontinuous capability improvements. (McKinsey Global Institute 2013).

Practically, above we have listed the McKinsey´s twelve disruptive technologies and their prior technological and economic impact and linked them to the analysis patents and trademarks. This list gives us robust guidelines to pay attention to relevant disruptive technologies in international patent and trademark analyses. In this paper we limit our analysis to new methodology, which is relevant for patent and trademark analyses, which have relevance for disruptive technology analyses.

Table 1. Twelve potentially economically disruptive technologies linked how them primary could affect society, businesses and economies (Source: McKinsey Global Institute (2013) Analysis: Tables E1 and E6).

Disruptive technologies	**Description**	**Primary economic impact**
Mobile Internet	Increasingly inexpensive and capable mobile computing devises and internet connectivity	Changes patterns of consumption Creates opportunities for Entrepreneurs Creates new products and services Drives economic growth or productivity
Automation of knowledge work	Intelligent software systems can perform knowledge work tasks involving unstructured commands and judgments	Changes nature of work Changes organizational structure Drives economic growth or productivity
The Internet of Things	Networks of low-cost sensors and actuators for data collection, monitoring, decision making, and process optimization	Changes quality of life, health and environment Creates new products and services Drives economic growth or productivity
Cloud technology	Use of computer hardware and software resources delivered over a network or Internet, often as a service	Changes patterns of consumption Creates opportunities for Entrepreneurs Creates new products and services Drives economic growth or productivity
Advanced robotics	Increasingly capable robots with enchanted senses, dexterity, and intelligent used to automate tasks	Changes quality of life, health and environment Changes nature of work Creates new products and services Drives economic growth or productivity
Autonomous and nearautonomous vehicles	Vehicles that can navigate and operate with reduced or no human intervention	Changes quality of life, health and environment Creates new products and services Poses new regulatory & legal challenges
Next-generation genomics	Fast, low-cost gene sequencing, advanced big data analytics, and synthetic biology (“writing” DNA)	Changes quality of life, health and environment Creates opportunities for Entrepreneurs Creates new products and services Poses new regulatory & legal challenges
Energy storage	Devices or systems that store energy for later use, including batteries	Changes quality of life, health and environment Shifts surplus for producers or industries
3D printing	Additive manufacturing techniques to create objects by printing layers of material based on digital models	Changes patterns of consumption Creates opportunities for Entrepreneurs Creates new products and services Drives economic growth or productivity
Advanced materials	Materials designed to have superior characteristics (e.g. strength, weight, conductivity) or functionality	Changes quality of life, health and Environment Creates new products and services
Advanced oil and gas exploration and recovery	Exploration and recovery techniques that make extraction of oil and gas economical	Shifts surplus between producers or industries Drives economic growth or productivity Changes comparative advantage for nations
Renewable energy	Generation of electricity from renewable sources with reduces harmful climate impact	Changes quality of life, health and environment Shifts surplus for producers or industries

Trademarks have been used for a long time to identify products and services. Trademarks are also a tool of branding. We can also link the trade of patents and trademarks to the open innovation paradigm (Kaivo-oja, Santonen 2016). Often trademarks and patents can help to discover new business models and technology innovations. (Roth et al. 2017, Kaivo-oja, Lauraeus 2017a, 2017b, 2017c).

- The innovative disruptive technologies that today drive economic growth and productivity are: Mobile Internet, Automation of knowledge work, Internet of Things, Cloud Technology, Advanced robotics, 3D printing, Advanced oil and gas exploration and recovery(McKinsey Global Institute 2013, Kaivo-oja and Lauraeus, 2017c).
- The innovative disruptive technologies that creates most the new products and services, and thus trademarks and patents are: Mobile Internet, Internet of Things, Cloud Technology, Advanced robotics, Autonomous vehicles, Next generation genomics, 3D printing and Advanced materials(McKinsey Global Institute 2013, Kaivo-oja, Lauraeus, 2017c).
- The innovative disruptive technologies, which create most opportunities for entrepreneurship and reason for companies to protect their technological innovations are: Mobile Internet, Cloud Technology, Next generation genomics and 3D printing(McKinsey Global Institute 2013, Kaivo-oja, Lauraeus, 2017c).
- The innovative disruptive technologies that changes patterns of consumption are: Mobile Internet, Cloud

Technology and 3D printing(McKinsey Global Institute 2013, Kaivo-oja, Lauraeus, 2017c).

Technological innovation drives long-term economic growth, so most countries attempt to provide an innovation-friendly environment that includes tightening protection of intellectual property rights (IPR). However, according to Woo, Jang and Kim (2015), debate continues on whether strengthened IPR lead to technological development and economic growth: patents and trademarks promote innovation by protecting appropriation from invention and disclosing knowledge to the public, but they also create excessive monopoly power that may impede further innovation (see Woo, Jang and Kim 2015).

Innovation technology management foresight and most important trends for year 2017:

The Hype Cycle for Emerging Technologies report is the longest-running annual Gartner Hype Cycle report, providing a cross-industry perspective on the technologies and trends that business strategists, corporate leaders, chief innovation officers, R&D leaders, entrepreneurs, global market developers and emerging-technology teams should consider in developing emerging-technology portfolios and future business (Gartner, August 2015). Technological innovations and disruption can be analysed by the phases of Gartner hype cycle. For company management, it is very important:(1) to monitor firm´s patent and trademark portfolios, (2) to decide, when and what they do with firm´s R&D activities, and (3) to decide how to utilize patents and trademark portfolios in relation to the Gartner´s hype cycle(Gartner, August 2017).

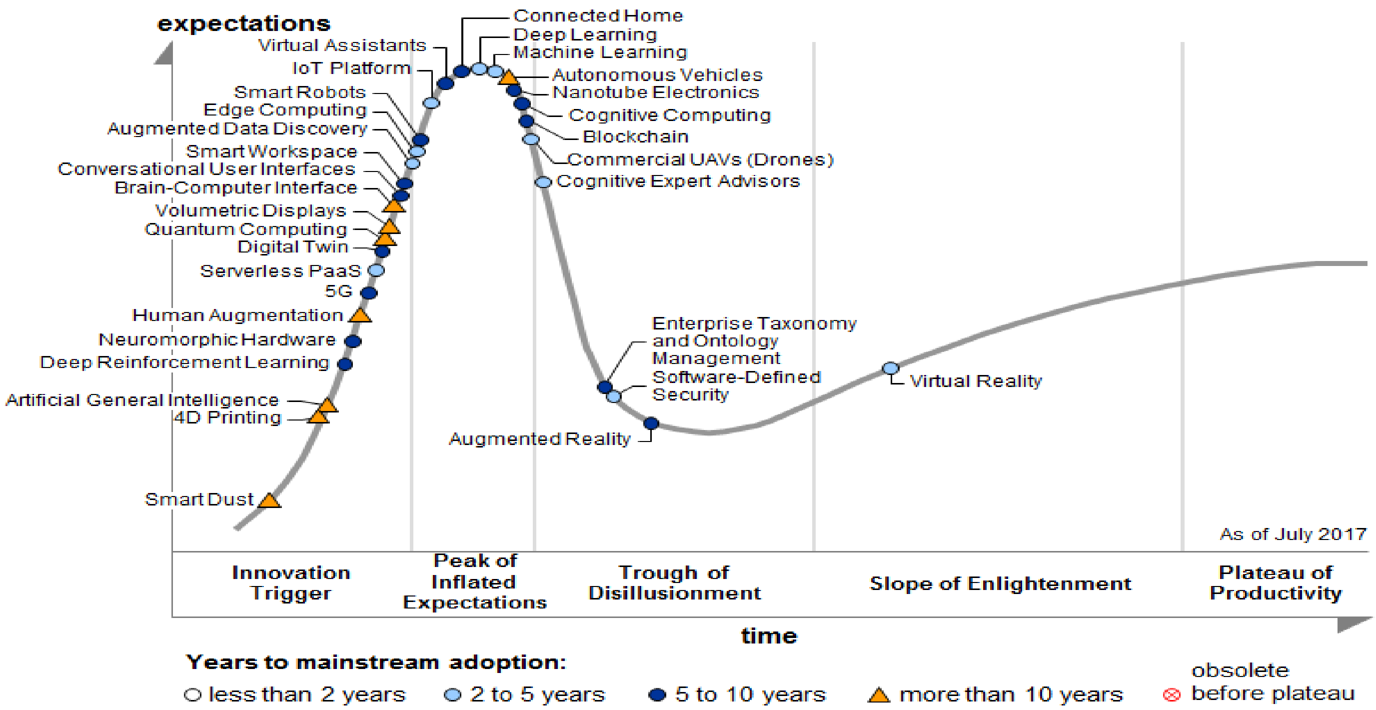

Figure 1. The emerging technologies on the Gartner Inc. Hype Cycle for Emerging Technologies, 2017 (Source: Gartner, July 2017).

Gartner identifies three megatrends that will drive digital business into the next decade: AI Everywhere, Transparently Immersive Experiences and Digital Platforms.

Trend 1: AI Everywhere:

Artificial intelligence technologies will be the most innovative and disruptive class of technologies over the next 10 years because large amounts of data, radical computational power, and unprecedented advances in networks. Organizations with AI technologies are able to adapt to new situations and solve problems that no one has ever encountered previously (Gartner, August 2017).

Enterprises that are seeking leverage in this theme should consider the following technologies (Gartner, August 2017): Deep Learning, Deep Reinforcement Learning, Artificial General Intelligence, Autonomous Vehicles, Cognitive Computing, Commercial UAVs (Drones), Conversational User Interfaces, Enterprise Taxonomy and Ontology Management, Machine Learning, Smart Dust, Smart Robots and Smart Workspace.

Trend 2: Transparently Immersive Experiences:

Technology will continue to become more human-centric and it will introduce transparency between people, businesses and things. This relationship will become much more entwined. The evolution of technology becomes more adaptive, contextual and fluid within the workplace, at home, and in interacting with businesses and other people (Gartner, August 2017).

Critical technologies to be considered include(Gartner, August 2017): 4D Printing, Augmented Reality (AR), Computer-Brain Interface, Connected Home, Human Augmentation, Nanotube Electronics, Virtual Reality (VR) and Volumetric Displays.

Trend 3: Digital Platforms:

Emerging innovative technologies require revolutionizing the enabling foundations that provide the volume of data needed, advanced compute power, and ubiquity-enabling ecosystems. The shift from compartmentalized technical infrastructure to ecosystem-enabling platforms is laying the foundations for entirely new business models that are forming the bridge between humans and technology (Gartner, August 2017).

Key platform-enabling technologies to track include (Gartner, August 2017) the following technologies: 5G, Digital Twin, Edge Computing, Blockchain, IoT Platform, Neuromorphic Hardware, Quantum Computing, Server less PaaS and Software-Defined Security.

In current technology development environment, AI Everywhere, Transparently Immersive Experiences and Digital Platforms together cause many potential disruptions in technological development and markets. However, these disruptions do not happen without patents and trademarks or without market structure changes. Thus, there is now stronger need to measure and analyze IPR portfolios with an exact method. Our novel LKI analysis can contribute to capturing relevant aspects of market and technology disruptions without portfolio or market scaling biases.

In Figure 2 we present our additional analysis of Gartner Hype Cycle analyses in 2008-2017. In a way this figure helps us to identify dominating IT technologies, which are also relevant for active patent and trademark analyses. The figure 2 reports the evaluation times of various IT technologies in the Gartner studies and evaluations in years 2008-2017. There are 151 IT technologies, which have been listed in the Gartner studies, but only these IT technologies have been ranked more than 4 times. This concrete criteria of ranking time may help us to filter out the most dominating IT technologies in the world. Our novel patent and trademark portfolio methodology can be used to analyze technologies linked with patent and trademark databases.

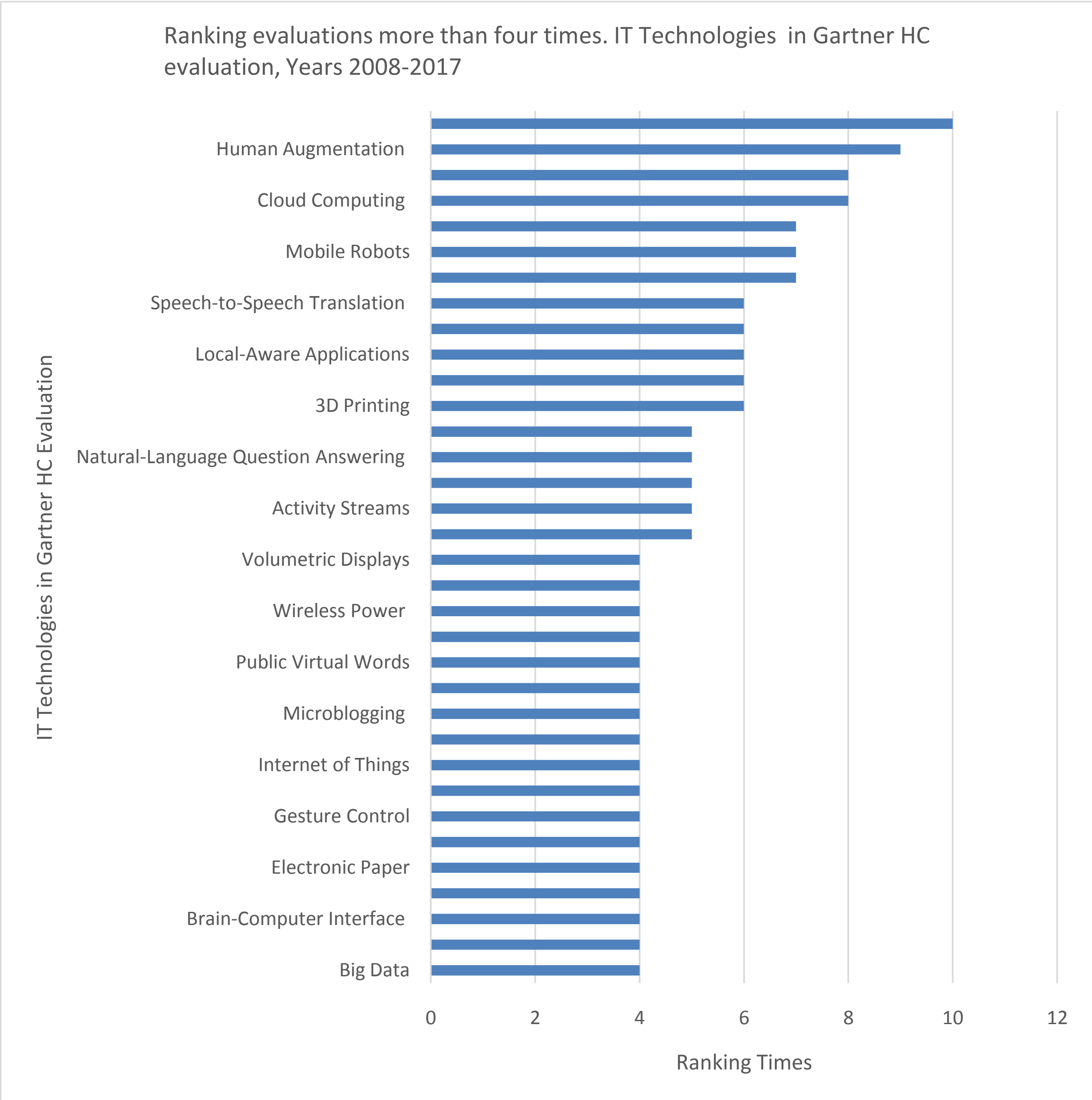

Figure 2. Ranking evaluations more than four times. IT Technologies in Gartner HC evaluation, Years 2008-2017. (Source Gartner 2008-2017).

This robust analysis of key IT technologies is good to keep in mind when experts and firms evaluate their patent and trademark portfolios.

Trademarks and technological disruption

Why are trademark-based indicators important for technological innovations and management:

Trademark-based indicators show promise for advancing research agendas concerned with (1) the rates and directions of product innovations in different industrial sectors, (2) international patterns of smart specialisation, (3) links between technological and marketing activities and (4) the evolution of economic organisations and structures.

The technological disruption and technological innovations can change market conditions and competition in markets in short time. Thus, it is important to understand market dynamics of trademarks (Kaivo-oja, Lauraeus 2017a, 2017b, 2017c):

a) The patents and trademarks link technological innovations, economic growth and profit, and marketing activities.
b) Patents and trademarks have a significant role in commercialization of technological innovations.
c) Without patents and trademarks, companies are not able to protect their own innovations and IPR portfolios.
d) Patents and trademarks strengthen company´s brand, which is typically based on technological innovations.
e) With patents and trademarks companies are able to have market dominance and competitive advantage.
f) Trademarks are essential part of company´s IPR portfolio.
g) With patents and trademarks, companies can prevent competitors entrance to their markets. Patents and trademarks are used as barriers against a new entry into markets.
h) The value of firms in knowledge intensive activities is determined by the value of its IP. Intellectual property is used as a financial asset.

From a knowledge management perspective, it is very important to understand how patent and trademark applications are submitted and utilised (Kaivo-oja, Lauraeus 2017a, 2017b, 2017c). For example, we can make better technological knowledge investments and knowledge management strategies, if we know more about the systemic dynamics of patent and trademark applications, and how they interlink with population and economic growth dynamics. It is very important to know how patents and trademarks are registered in the global setting (see e.g. Kaivo-oja 2016).

According to Hanel´s review (2006)numerous articles show that management of knowledge assets in general, and IPRs in particular are increasingly important. The value of firms in knowledge intensive activities is determined by the value of its IP. IP is used as a financial asset. Firms allocate more human resources to management of IPRs and their training, but there remain important international differences. Hanel 2006 studied and reviewed the recent literature on the impact of IP on the value of the firm, its assessment, valuation, accounting and management.

A successful innovation ecosystem depends on knowledge, which can be technological, strategic, and market related. Information and data about patents and trademarks are always the result of knowledge management processes. Existing knowledge base and stock contribute directly to the novelty or complexity of new innovations, whether they are technological innovations, business model innovations or social innovations. (Kaivo-oja 2011, Roper, Hewitt–Dundas 2015, Roth, Melkonyan, Kaivo-oja, Dana 2017).

Recently, patent forecasting and planning has been emphasized as an essential process in the strategic management of technology, because well-planned patents will make larger profits and occupy dominant positions earlier (Jeong, Yoon 2016). Jeong and Yoon (2016) suggest the concept and process of a patent roadmap based on a technology roadmap and patterns of patent development.

The cyclical model of entrepreneurship and technological innovation links entrepreneurship to four domains: (1) scientific exploration, (2) technological research, (3) market transitions, and(4) product creation. Between scientific exploration and technological research, there is the natural and life science cycle. Between scientific and market transitions there is the social and behavioural science cycle. Between technological research and product, creation there is the integrated engineering cycle. Finally, between market transitions and product creation there is the differentiated service cycle. These four cycles are important dynamic forces in innovation ecosystems and technology innovation management. The natural and life science cycle creates technical capabilities. Patents are typically linked to the natural and life science cycle. The social and behavioural science cycle creates social insights. Trademarks are typically linked to the social and behavioural cycle. The differentiated services cycle creates customer value. The integrated engineering cycle creates products (see Berkhout, Hartmann, van der Duin, Ortt 2006, Trott, Hartmann, van der Duin, Scholten, Ortt 2016, 20). It is important to analyse these two cycles when we analyse technological innovation ecosystems (see more in Kaivo-oja 2016). Our analysis in this article providesauseful new tool for these analytic evaluation purposes.

Trademark-based indicators (for example,the Herfindahl–Hirschman Index and Lauraeus-Kaivo-oja Index) are the measurements used to understand the level of competition that exists within a market or industry or technological innovations, as well astogive an indication of how the distribution of market share occurs across the companies included in the index(Kaivo-oja, Lauraeus 2017a, 2017b, 2017c). Understanding the level of technological and market competition can be important for strategic planning as well as when trying to establish pricing for a company’s products or services (Hannah, Kay 1977, Adams2017).

Mostanalystsdo some sort of industry analysis to understand where a particular company's source of growth and competitive advantage comes from, and competition or market structure is one of the main conventional elements of industry analysis. Thus, if a company exists in a highly competitive industry, it will be more difficult for it to maintain above-average profit marginsin the future, even if it has above-average profit margins today. For example, the Justice Department of the United States uses theHerfindahl–Hirschman Index to decide whether amergeris good for competition in the marketplace (the Hannah, Kay 1977, Calkins 1983, Justice Department in the Unites States 2015).

There are always changes in technology and innovation activity. In this article, our aim is to analyse long–run changes of innovation activity. Innovation activity is, in this paper, limited to two key indicators: patents and trademarks. Patents are often used to analyse technological capability (Tong, Frame 1994, Abraham, Moitra 2001, Lee et al 2015). Trademarks are often used to analyse technological and commercial business competences of countries. A trademark is a sign capable of distinguishing the goods or services of one enterprise from those of other enterprises (Mendonca, Pereira, Godinho 2004, Hidalgo, Gabaly 2013). Patents and trademarks are also used as barriers against entry into markets (see e.g. Demsetz 1982). This aspect of market entry is relevant for the European Union in the global competition. The unique character of products and services is a key issue in global markets. There is also a considerable market value for R&D, patents, and trademarks (Sandner, Block 2011). In global markets, trademarks are protected by intellectual property rights and by legal authorities.

THEORETICAL AND EMPIRICAL FRAMEWORK AND LAURAEUS-KAIVO-OJA INDEX ANALYSIS

In chapter 3, we will introduce the classical Herfindahl–Hirschman Index (HHI index) and based on that, we will develop a novel trademark-based indicator, the LKI, which will be a more easily comprehensible analysis tool than the conventional HHI index. We shall introduce the novel monitoring indicator in this chapter.

In this study, we base our empirical analyses on the international classification and updated statistical database of the Finnish Patent and Registration Office (2017). In Finland, the classification of trademarks has 34 classes of goods, and 11 classes of services.

The advantages of Lauraeus-Kaivo-oja Index:

The LKI approach, which we will present next in this paper, allows the possibility of a separate-sized portfolio analyses of product trademarks and service trademarks. There is not statistical bias in the comparison of trademark portfolios with different size, when we present the LKI analyses. In the field market and IPR portfolio analyses the statistical comparisons has been a hidden problem for a long time, but now this problem is solved by the LKI approach. We expect, that especially market experience, the impact of disruptive technologies, and associated trademarks, increases the strategic role of patent and trademark portfolio analyses.

The size-independent analysis of IPR portfolios is a novel thing, which is having broad implications for the analysis of technological innovations but also for the analysis of business model innovations. LKI approach allows the size of the IPR portfolio to be different and the results are not dependent on the size of IPR portfolio. This is the big advantage with respect to conventional HHI approach. This is a key methodological issue in the case of our empirical analyses.

As the well-known HHI Index, also the LKI approach helps us to understand the dynamics of the market and IPR structures and especially the importance of ownership and management structures when we develop novel technological innovations. The HHI and other concentration indices are widely used in competition policy and industrial policy - as well as in international trade analysis. Thus, also a novel LKI approach have wide potential for use in the fields of analyses. We are using large statistical data of trademarks of goods and services, rather than limiting analyzes only for technology innovations. We admit that patent and trademark strategies are complementary strategies in companies and corporations.

The Herfindahl–Hirschman Index (HHIindex)definition:

The term "HHI" means the Herfindahl–Hirschman Index, a commonly accepted measurement of market concentration. The Herfindahl–Hirschman Index, HHI is a measure of the size of firms in relation to the industry and an indicator of the amount of competition among them. Named after economists Orris C. Herfindahland Albert O. Hirschman, it is an economic concept widely applied in the fields of competition law, antitrust legislation and technology management (see e.g. Calkins 1983).

The HHI index is defined as the sum of the squares of the market shares of the firms within the industry (typically limited to the 50 largest firms), where the market shares are expressed as fractions. The result is proportional to the average market share, weighted by market share. As such, it can range from 0 to 1.0, moving from a huge number of very small firms to a single monopolistic firm. Increases in the Herfindahl–Hirschman Index generally indicate a decrease in competition and an increase of market power, whereas decreases indicate the opposite development.

The major benefit of the Herfindahl–Hirschman Index in relation to measurements such as the concentration ratio is that it gives more weight to larger firms. The HHI index takes into account the relative size distribution of firms in a market. It approaches zero when a market is occupied by a large number of firms of relatively equal size and reaches its maximum of 10,000 points when a market is controlled by a single firm. The Herfindahl–Hirschman Index increases both as the number of firms in the market decreases and as the disparity in size between those firms increases.

The measure is essentially equivalent to the Simpson diversity index (Simpson 1949), which is a diversity index used in ecology, and to the inverse participation ratio (IPR) in physics. Thus, there are some analogies to basic measurements in natural sciences and physics (Hoyer 2011). The measurement logic and rationality of market analyses is a scientifically relevant issue to study and develop further.

The Calculation of the Herfindahl–Hirschman Index:

The calculation of the HHI differs from the standard Concentration Ratio in that it squares each market share value, which places a higher importance on those top companies that have a larger market share. The formula for determining the HHI is as follows:(Herfindahl 1950, Hirschman 1964, Adams 2017).

The HHI is calculated by taking the market share of each firm in the industry, squaring them, and totalling up the result (Rhoades 1993, 188):

HHI $=\sum_{i=1}^{n}(MS)_i{}^2$.

The HHI accounts for the number of firms in a market, as well as concentration, by incorporating the relative size (market share, MS) of all firms in a market. The HHI is calculated by squaring the market share of each firm competing in the market and then totalling up the resulting numbers. For example, for a market consisting of four firms with shares of 30, 30, 20, and 20 percentages, the HHI will be 2,600 (302 + 302 + 202 + 202 = 2,600). In Fig. 3, we have calculated the HHI indexes for Finnish trademark registration.

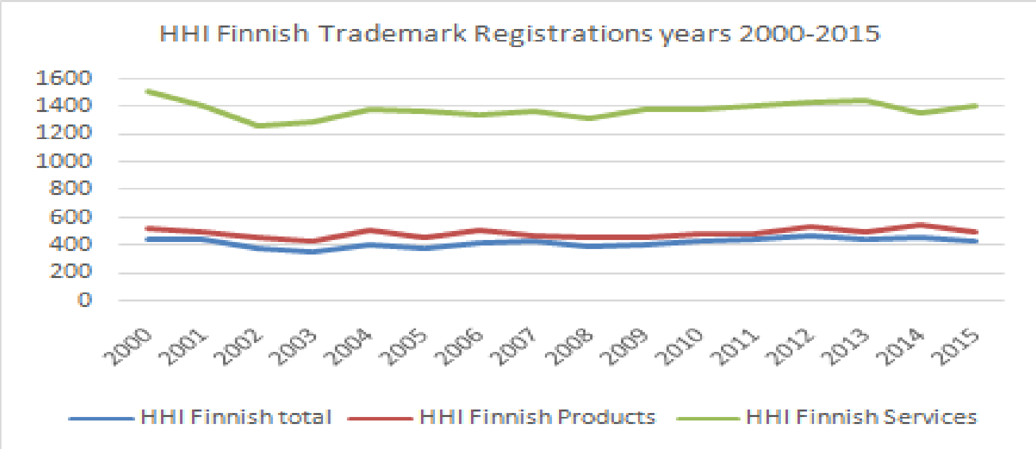

Figure 3. HHI analysis: Total Finnish trademark registration to Finland. (Data: Finnish Patent and Registration Office 2017).

We can note that HHI is higher in the field of Finnish services compare to Finnish good. HHI is lower in the field of Finnish goods. We can conclude there is more competition in the field of trademark categories of Finnish services compared to the categories of Finnish goods.

The original reason why we started to develop the Lauraeus-Kaivo-oja Index (LKI)is the following:Fig.3 shows that we are not able to compare products and services together with the conventional HHI index. There are 34 classes of products and only 11 classes of services. Thus, the number of classes will distort empirical results and have a large-scale negative effect on the HHI index values of services compared to product values. We are not able to achieve generalised and comparable results with the HHI index analyses in this special situation, when classifications differ.

Next, we will present the calculation and every step from the Herfindahl–Hirschman Index (HHI) to the LKI. We aim to provide a novel method to analyse IPR portfolios and markets. This kind of novel index is useful for various fields of research policy planning and research. It is also a relevant novel approach for when we want to compare different markets and IPR portfolios with different sample size numbers.

The Calculation of the Lauraeus-Kaivo-oja Index:

The calculation of the LKI index creation isbased on the Herfindahl–Hirschman Index demonstrated, using a mathematic formula, HHI, as:

HHI = s1^2 + s2^2 + s3^2 + ... + sn^2, (1)

which can be written using the mathematic formula:

HHI $= \sum_1^k(\frac{100*n_i}{N})^2$, (2)

Where the whole quantity of the sample = N, the number of different classes in the sample = k, and, the average value of the sample classes = $\bar{n}$.We do not need 100^2 for anything, so we can remove it. We can write the percentages as well with the decimals of 0.01-0.99, which means the same as 1% - 99%. Thus, then we will not have a problem of values 0-10000, which are more difficult to understand than normal percentage value.

Thus, we re-mark the index hhi, which means HHI without 100^2.

$\mathrm{HHI} = 100^2 * \mathrm{hhi} = 10000*\mathrm{hhi}$ (3)

Thus, we´ll take out the100^2 and we will change the HHI formula to the new name“hhi”, which is:

hhi$= \sum_1^k(\frac{n_i}{N})^2$ (4)

which means the same as:

hhi$= \frac{1}{N^2}\sum_1^k(n_i)^2$. (5)

On the other hand, the whole quantity of the sample is = N. Which is the same thing as the number of different classes in the sample Thetotal sumin the sample classes is:

N=k$*\,\bar{n}$= k$\bar{n}$ (6)

Thus, we can write the “hhi” formula as

hhi$= \frac{1}{\mathrm{k}\bar{n}^2}\sum_1^k(n_i)^2$ (7)

Then, the same “hhi” index can be presented as

hhi$=\frac{\delta^2}{\mathrm{k}\bar{n}^2} + \frac{1}{k}$ (8)

When $\frac{1}{k}$means 1 over k number of classes of the sample. We do not need that $\frac{1}{k}$ for anything. Otherwise, we will have a distorted big picture of key trends. If you have different numbers of classes in the sample, then you are not able to compare the different classes with each other or it will distort the analytical analysis.

For example, this statistical sample of trademarks consists of 34 classes of goods ($\frac{1}{k}$ = $\frac{1}{34}$ =0,029 =2,9%) and services 11 classes ($\frac{1}{k}$ = $\frac{1}{11}$ =0.09=9%). That analysis situation means, the fewer the classes, the bigger the percent number added to the "hhi" will be. Thus, let us ask, why this kind of percentage number should be added to the index? We can remove $\frac{1}{k}$, and thus, we will have a better, more informative and more relevant trend curve.

$$\text{"lki"}=\frac{\delta^2}{k\bar{n}^2} \quad (9)$$

The completely divided material, where all of numbers of the samples are in one class $\frac{1}{k}$ = $\frac{1}{1}$ =1. The maximal diaconal standard deviation is δ^2=(k-1)n^2 . That is why the divisor must be (k-1). The wrong divider is $\frac{\delta^2}{k\bar{n}^2}$, and the right one is (k-1) n^2. We will have the LKI, where the square of standard deviation over completely divided square of standard deviation is.

Thus, the new novel indicator will be:

$$\text{LKI}=\frac{\delta^2}{(k-1)\bar{n}^2} \quad (10)$$

Finally, if we take the square root of LKI, the linear LKI can be written as:

$$\text{LKI linear index} = \frac{\delta}{\bar{n}\ \sqrt{k-1}} \quad (11)$$

This will be a linear curve if the changes are linear. Thus, the other curves (HHI, hhi, LKI) are parable curves. We hope that this kind of novel index will be useful in various evaluations and measurements.

RESULTS OF TRADEMARK COMPETITION ANALYSES

The Dynamics of Trademark Competition in Finland Based on the Number of Finnish and International Registrations from 2000-2015 by the Full Category Data of 45 Sectors:

First, we will report on the Finnish and International trademark registrations to Finland. Secondly, we will report on the Finnish trademark registrations years 2000-2015 by the Full Category Data of 45 Sectors. Thirdly, we will report on the international trademark registrations to Finland years 2000-2015 by the Full Category Data of 45 Sectors. Finally, we´ll show sectoral observations about the dynamics of trademark registrations (see Fig 4, Fig 5 and Fig. 6).

Figure 4. The dynamics of trademark competition in Finland, based on the number of Finnish and international registrations from 2000-2015 by the full category data of 45 sectors.(Data: Finnish Patent and Registration Office [2017]).

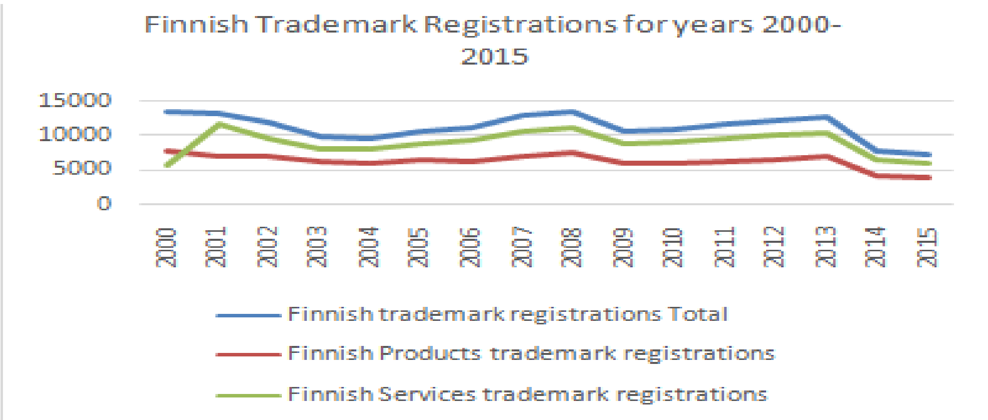

Figure 5. Finnish trademark registrations for years 2000-2015 by the full category data of 45 Sectors. (Data: Finnish Patent and Registration Office [2017]).

The number of trademark registrations in Finland has decreased since the year 2000, both in the fields of national and international trademarks.

Trademark registrations have been quite stable in Finland, but product trademark registrations have declined involume compared to services trademark registrations. The total volume of Finnish trademark registrations has decreased quite significantly since the year 2000. A considerable decrease in registration volumes (from over 12,000 trademark registrations to less than 8,000 trademark registrations) happened from 2014-2015.

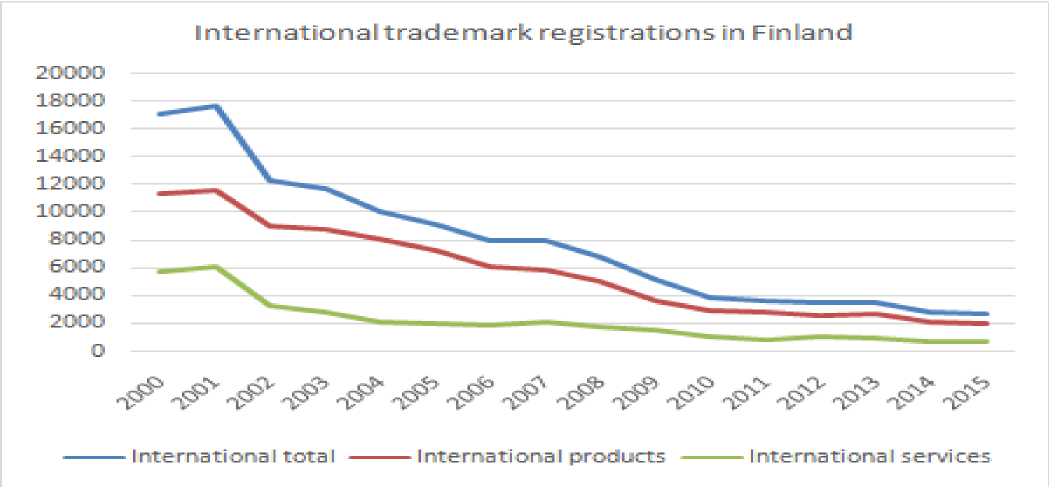

Figure 6. International trademark registrations in Finland years 2000-2015 by the full category data of 45 sectors. (Data: Finnish Patent and Registration Office (2017).

Fig. 6 shows that international trademark registrations have decreased significantly from2000-2015. The total volume of international registrations has decreased dramatically;a reduction 84% from the year 2000 (17,066 registrations in 2000, but only 2,689 in 2015).

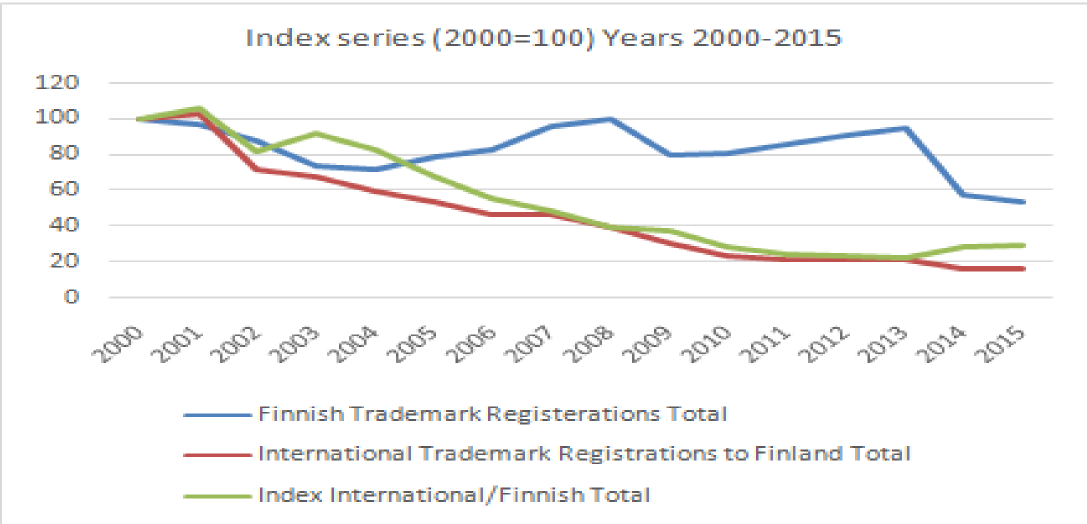

Figure 7. Sectoral observations on the dynamics of registrations from years 2000-2015 (Index series 2000=100). Data: Finnish Patent and Registration Office (2017).

Fig. 7 reports that international trademark registrations have decreased more dramatically than Finnish national trademark registrations. The volume of international trademark registrations is, in 2015, less than 20% of the international volumethat itwas in 2000.

A result of this, (aswe can see from figures 3-7) is the decreasing trend in trademark registrations, in both the Finnish and international sectors. The turning point was in the year 2001, when the volume of trademark applications took a downward turn; see Fig. 6.In this article, we do not want to speculate about there a sons why this turning point was in the year 2001, but we can just present a scholarly guess that it was linked to the economic problems of Nokia in Finland and the crisis of the international ICT cluster (so called "Dotcom Bubble", see Lowenstein 2004).

Trademark registrations have decreased in all sectors, but it is at international level that registrations have reduced most of all. The international trademark registration trend curve is decreasing. In the year 2000, there were 17,066trademark registrations and the year 2015, there were only 2,689 registrations. There is a big drop on the international trademark registration curve.

Therefore, Finnish trademark registrations 2015 have also decreased to half of what they were in the year 2000. In the year 2000, the trend curve showed13,338 trademarks, whereas fifteen years later, in 2015, it shows only half of that;just7,188 trademark registrations.

Comparing the HHI index, hhiindex and LKI index together:

The Herfindahl–Hirschman Index demonstrated the mathematic formula, HHI as:

HHI = s1^2 + s2^2 + s3^2 + ... + sn^2, (1)

Which can be written as the mathematic formula:

$$HHI = \sum_1^k \left(\frac{100 * n_i}{N} \right)^2 \quad (2)$$

Figure 8. HHI index for Finnish and international trademarks and total registrations. (Data: Finnish Patent and Registration Office [2017]).

Fig. 8 informs us that the concentration of trademark registration categories is higher in the field of services compared to products. This indicates higher competition in the field of product registrations compared to service registrations.

Thus, we re-mark the index hhi, which means HHI index, without 100^2:

$$HHI = 100^2 * hhi = 10000 * hhi \quad (3)$$

Thus, we´ll take away the100^2 and we´ll change the HHI formula to the new name "hhi",

$$hhi = \sum_1^k \left(\frac{n_i}{N} \right)^2 \quad (4)$$

which means the same as

$$hhi = \frac{1}{N^2} \sum_1^k (n_i)^2. \quad (5)$$

On the other hand, the whole quantity of sample = N.
Which is the same thing as the number of different classes in the sample * The total sum of the sample classes:

$$N = k * \bar{n} = k\bar{n} \quad (6)$$

Thus, we can write the "hhi" formula as

$$hhi = \frac{1}{k\bar{n}^2} \sum_1^k (n_i)^2 \quad (7)$$

Then, the same "hhi" index can be presented as

$$hhi = \frac{\delta^2}{k\bar{n}^2} + \frac{1}{k} \quad (8)$$

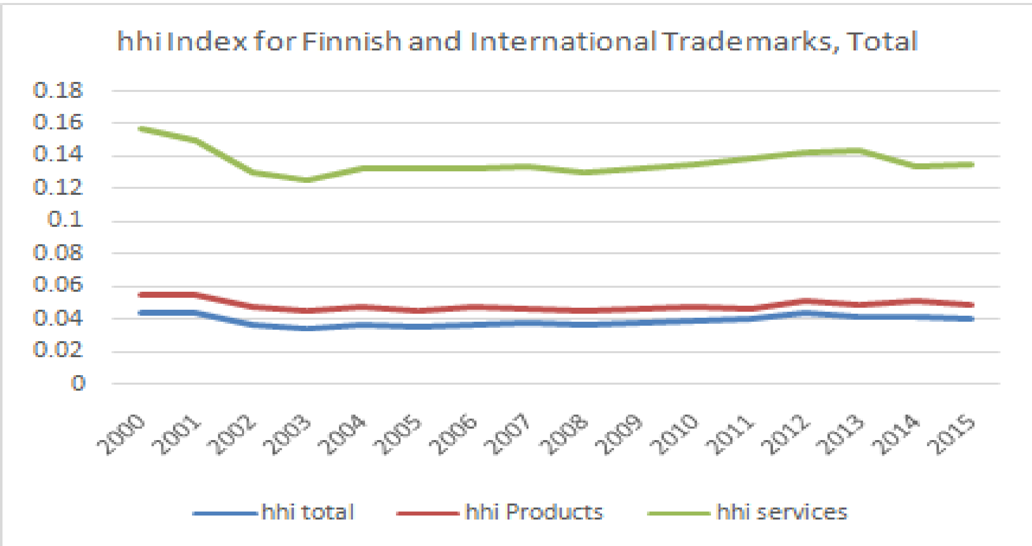

Figure 9. The hhi index for Finnish and international trademarks and total registrations. (Data: Finnish Patent and Registration Office [2017]).

Fig. 8 and Fig. 9 are indicating similar conclusions with Fig. 7. The concentration of trademark registration categories is higher in the field of services compared to products. Competition in the field of all trademark categories is highest. There is higher competition in the field of product registrations compared to service registrations, which probably indicates increasing role of disruptive technologies. Total trademark registrations market is a very competitive market.

We can remove $\frac{1}{k}$ and thus, we will have a better trend curve.

"lki"= $\frac{\delta^2}{k\bar{n}^2}$ (9)

Completely divided material, where all sample numbers are in one class $\frac{1}{k}=\frac{1}{1}=1$.

The maximal diaconal standard deviation is δ^2=(k-1)n^2. That is why the divisor must be (k-1). The wrong divider is $\frac{\delta^2}{k\bar{n}^2}$, and the right one is (k-1) n^2, Thus, the new indicator will be

LKI= $\frac{\delta^2}{(k-1)\bar{n}^2}$ (10)

We will use the Lauraeus & Kaivo-oja index (LKI), where the square of standard deviation is over the completely divided square of standard deviation. Fig. 10 shows us that LKI is highest in total services registrations. Total (Finnish and international) and total product trademark registrations have lower LKIs. This result indicates that there should be more competition in the field of service trademark registrations.

Figure 10. LKI index for Finnish and international trademarks and total registrations. (Data: Finnish Patent and Registration Office [2017]).

Finally, if we take away the square of the LKI index, so the linear LKI can be written as

LKI linear index = $\frac{\delta}{\bar{n} \sqrt{k-1}}$ (11)

This will be linear curve, when the other curves (HHI, hhi, LKI) were parable curves.

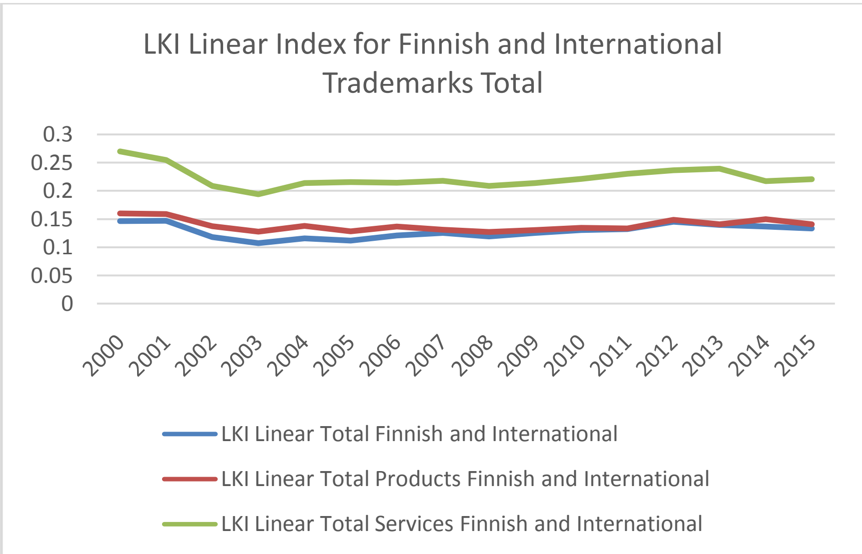

Figure11. LKI Linear Index for Finnish and International Trademarks, Total.

Now we have reported our results with the conventional Herfindahl–Hirschman Index and with the novel LKI linear index. These analysis results provide an empirical demonstration with trademarks statistics about scientific relevance of a novel approach. Because we analysed both product and service categories, we were able to link our analyses to technology driven products, too.

COMPARATIVE PERSPECTIVES

Comparing the HHI index and LKI index together:

Whole number or percentage to measure market competition level:

Within the HHI index, the market share of each firm is expressed as a whole number, while for the LKI index, the market share of each firm is expressed as a decimal of the percentage value.

The HHI can have a theoretical value ranging from close to zero to 10,000. The LKI can have a theoretical value ranging from close to 0,00 to 1,00 – the same as 0% - 100%, which we find more comprehensive.

Market analysis I: Monopoly:

The closer a market is to be a monopoly, the higher the market's concentration (and the lower its competition). If, for example, there was only one firm in an industry, that firm would have a 100% market share, and the HHI would equal 10,000, indicating a monopoly. In the same situation, the LKI would equal 1.00, which is the same as 100%, indicating a monopoly. We think that percentage value is easier and more comprehensive to use.

Market analysis II: Nearly perfect competition:

If there were thousands of firms competing, each would have nearly a 0% market share, and the HHI would be close to zero, indicating nearly perfect competition. In the same situation of nearly perfect competition, the LKI would be 0.00 or 0%.

In summary, the LKI percentage values are more comprehensible than the HHI values calculated with 100^2.There is not a bias towards large companies.

The HHIindex concentration ratio gives more weight to larger firms:

The Herfindahl–Hirschman Index, in relation to measures such as the concentration ratio, gives more weight to larger firms. (Rhoades 1993, Adams 2017). We think that this is not a good idea when you are comparing the different size of companies or different size of trademark groups.

The HHI takes into account the relative size distribution of firms in a market. It approaches zero when a market is occupied by a large number of firms of relatively equal size and reaches its maximum of 10,000 points when a market is controlled by a single firm. In this situation the Lauraeus-Kaivo-oja Index(LKI) will be 1,00 or 100%.

For laymen and other experts, the LKI number is easier to understand than the HHI, which provides large numbers for decision-makers to consider.

The HHI increases both as the number of firms in the market decreases and as the disparity in size between those firms increases:

The original reason why we started to develop the HHI index further is because Table 1 shows that we are not able to compare products and services trademarks together with the HHI index. There are 34 classes of products and only 11 classes of services. Thus, the number of classes will distort evaluation results and would have a large-scalenegative effect on the HHIindex values of services compared to product values. There are good reasons to avoid this potential statistical bias.

CONCLUSIONS

Trademark-based indicators are important for technological innovations and management:

The innovative disruptive technologies that drives most economic growth and productivity are: Mobile Internet, Automation of knowledge work, Internet of Things, Cloud Technology, Advanced robotics, 3D printing, Advanced oil and gas exploration and recovery. The three disruptive technologies that changes patterns of consumption, creates new entrepreneurship. They create new products and services in the fields of Mobile Internet, Cloud Technology and 3D printing (Gartner, August 2017, Kaivo-oja, Laureus 2017a).

Recent Gartner study (2017) identifies three megatrends that will drive digital business into the next decade: AI Everywhere, Transparently Immersive Experiences and Digital Platforms. Artificial intelligence technologies will be the most innovative and disruptive class of technologies over the next 10 years. Technology will continue to become more human-centric to the point where it will introduce transparency between people, businesses and things. The shift from compartmentalized technical infrastructure to ecosystem-enabling platforms is laying the foundations for entirely new business models that are forming the bridge between humans and technology.

The technological disruption and technological innovations can change market conditions and competition in markets in short time. Thus, it is important to understand market dynamics of trademarks (Kaivo-oja, Lauraeus 2017a, 2017b, 2017c).

The patents and trademarks link technological innovations, economic growth and profit, and marketing activities. Patents and trademarks have a significant role in commercialization of technological innovations. However, without patents and trademarks, companies are not able to protect their own technological innovations and products. Patents and trademarks strengthen company´s brand, which is based on technological innovations. Further, with patents and trademarks companies are able to have market dominance and competitive advantage.Trademarks are essential part of company´s IPR portfolio. With patents and trademarks, companies can prevent competitors entrance to their markets. Patents and trademarks are used as barriers against entry into markets. They can also be used in their open innovation strategy. The value of firms in knowledge intensive activities is determined by the value of its IP. IP is used as a financial asset.

It would be useful to evaluate different product categories and service categories with a new LKI method to identify disruptive changes in markets and IPRs.Trademark-based indicators (for example, the Herfindahl–Hirschman Index, HHI and Lauraeus-Kaivo-oja Index, LKI) are the measurements, which can be used to understand the level of competition that exists within a market or industry or technological innovations, as well as to give an indication of how the distribution of market share occurs across the companies included in the index calculation(see Kaivo-oja, Lauraeus 2017a, 2017b, 2017c).

The final conclusions of the novel LKI:

We developed the statistical LKI method for four reasons:

Firstly, Fig.3 shows that we are not able to compare products and services with the HHI index. The curve differences come from the different quantity of trademark classes. There are 34 classes of products and only 11 classes of services. The number of classes will distort and have a large-scale negative effect on the HHI index values. In order to eliminate statistical evaluation bias caused by various alternative product/service categorisations, we have introduced a new method to evaluate IPR portfolios (trademark and patent portfolios) and markets.

Secondly, we do not know why the number of classes' percentage is added to the index, when$\frac{1}{k}$ means 1 over k number of classes of the sample. That will lead to distorted picture of trademark registration trends in our case study analysis. If you have different numbers of classes in the sample, then you are not able to compare the different classes with each other, or otherwise it will distort the big picture of all IPR portfolio analyses. This is the practical reason why we decided to develop further the conventional and popular HHI method.

Thirdly, The HHI increases both as the number of firms in the market decreases and as the disparity in size between those firms increases.

Finally, we do not need 100^2 for anything, because it is clearer to write the percentages with the decimals of 0.01-0.99, which means the same as 1% - 99%. Thus, we will not have a problem with values 0-10000, which are more difficult to understand compared to normal percent value.

Those were the main practical reasons for creating a novel statistical LKI method. We developed the LKI, where the square of standard deviation is over the completely divided square of standard deviation:

$$\text{LKI}= \frac{\delta^2}{(k-1)\bar{n}^2}$$

Finally, if we take away the square root of the LKI, we will have a linear LKI:

$$\text{LK linear index} = \frac{\delta}{\bar{n} \quad \sqrt{k}-1}$$

We recommend usingthe LKI, where classifications of markets and IPR portfolios vary in statistical databases. It is very typical that in different markets and IPR portfolios, the size of categories varies and that is why there is a need to use the LKI.

The implications to theory, practice and policy:

The LKI is novel statistical index which is not sensitive to the portfolio size in comparative measurements, as the HHI index is. This is theoretical and methodological advantage and enables scientific and objective comparison of IPR portfolio analyses of different sizes. The use of LKI improves the exactness of measurements in market and IPR portfolio analyses.

There are many practical implications of the novel LKI approach. For example, the organizations, which monitor and analyze the dynamic changes of patents and brand portfolios, will get a new tool for their analyses. Also, STI policy makers will get a new tool for them. In general, all IPR analysts all over the world get access to a new tool for their market structure data or possible Big Data analyses. This new statistical approach has also high research potential in the fields of competition policy, IPR portfolio analysis in science, technology and innovation policy (STI policy). For example, we could analyze EU brand portfolios with national and Euro trademark and patent data without potential statistical biases. The new method can also be used for market analysis, including competitive business analyses in companies and corporations. For example, Porter's classical strategy analysis (Porter 1980) can be enriched with the use of the LKI analyses with different portfolios of products and services.

It is important to understand that there are interactions between trademark and patent portfolios. Trademarks and patents are complementary and there are interesting interactions between them (see e.g. Kaivo-oja 2016). Many firms use trademarks (and brands) are key variable of their competitive strategy. In some case this kind of competition strategy can be seen as disruptive and noise producing approach. However, we can claim that trademarks are part of the technological and competitive disruption like patents are too. By new trademark and product novelties firms attract new potential customers and end-users. Today the nature of the competition is such that new brands are to be offered and new entrants and players are testing, sensing and piloting new market places and potentials by new trademarks. Today companies and corporations - especially from the BRICS countries - have very aggressive strategies, which nowadays can be seen in global trademark and patent data (see Kaivo-oja, Lauraeus 2017d, 2017e).

The empirical findings of the trademark activity and trends:

The empirical results of this article indicate that trademark applications play an important strategic role in the Finnish technological innovation ecosystem. In this paper, the long-run innovation activity trends in Finland were analysed. As a result, we can see the decreasing trend in trademark registrations, both in the Finnish and international sectors. The turning point was in the year 2001 when the volume of trademark applications took a downward turn (see Fig. 5).

Referring to the analyses of this empirical study, we can note that technological and economic capabilities does not produce or generate so many trademarks as they did before in Finland. Trademark registrations have decreased in all sectors, but it is at international level that registrations have reduced most of all. The international trademark registration trend curve is decreasing. In the year 2000 there were 17,066 trademark registrations, but in the year 2015, there were only 2,689. There is a big drop on the international curve. At the same time, Finnish registrations 2015 have also decreased to half of what they were in the year 2000. In the year 2000, the trend curve showed 13,338 trademarks, but fifteen years later, in 2015, it shows only half of that; thus only 7,188 trademark registrations.

The empirical findings of this article indicate considerable change in innovation and knowledge management culture in Finland and internationally. The strategic role of trademark activity is weakening, when we assess this issue with the trends of trademark statistics.

This study informs us that in Finland there is less potential to scale barriers for entry into markets, when we study long-term trademark activity and its dynamics. Thus, in the year 2015, there are not so many new barriers for entry into markets, compared to in the year 2000, when we consider the issue of trademark registrations. Also, the impact of open innovation markets can be seen in decreasing trademark activity, but this issue requires further research and analysis.

One key finding on the basis of HHI and LKI measurements in our study is that competition in categories of trademark registrations is higher in the field of product trademark registrations compared to services registrations. If we analyse the total trademark registration situation with statistical HHI and LKI measurements in Finland, we can conclude that there is, in general, quite significant competition in categories of total trademark registration activity. However, lower trademark registration activity (both national and international trademark registration) in Finland raises some questions that trademark markets in Finland are nowadays not as competitive as they used to be in 2000.Thegeneral trend has been that fewer and fewer trademark registrations are carried out in Finland.

Future studies:

First of all, it is important to investigate the LKI index values of different technological innovation categories as pointed out in first chapters. LKI analysis can be applied to the analysis of the market structures of different products and services. Further, we will calculate the LKI index values for the moderately concentrated marketplace and the highly concentrated marketplace, which will reveal new aspects of market dynamics and technological development.As we pointed out at the beginning of this article, the LKI analysis is particularly useful when assessing the changes in the market caused by disruptive technologies. The LKI analysis is a useful method especially for analysing different sized markets and IPR portfolios.Results calculated using the new LKI method produce consistent results even if the size of the market or IPR portfolio would be different in different product or service categories.

REFERENCES

[1]. Abraham, B.P.; Moitra, S.D. 2001. Innovation assessment through patent analysis. *Technovation* 21(4): 245–252.

[2]. Adams, C. 2017. What is the Herfindahl Hirschman Index (HHI) and why would you use it? *Modern analyst*. Read 18.6.2017. Available at: http://www.modernanalyst.com/Careers/InterviewQuestions/tabid/128/ID/1003/What-is-the-Herfindahl-Hirschman-Index-HHI-and-why-would-you-use-it.aspx

[3]. Berkhout, A.J, Hartmann, D., van der Duin, P.A., Ortt, R. 2006. Innovating the innovation process. *International Journal of Technology Management* 34(3/4: 390-404.

[4]. Calkins, S. 1983. The new merger guidelines and the Herfindahl-Hirschman Index, *California Law Review* 71(2): 402-429. Read 18.6.2017. Available at: http://scholarship.law.berkeley.edu/californialawreview/vol71/iss2/6

[5]. Da Silva Lopes, T.; Duguid, P. (Eds.) 2010.*Trademarks, Brands and Competitiveness*. Routledge, New York and London.

[6]. Demsetz, H. 1982. Barriers to entry. *American Economic Review* 72(1): 47–57.

[7]. Finnish Patent and Registration Office (2017) Trademark data. Helsinki. Read 18.6.2017. Available at: https://www.prh.fi/en/tavaramerkit/tavaramerkkitietokannat.html

[8]. Gartner Ltd. 2008.*Gartner Hype Cycle 2008*. Figure.
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Gartner Ltd. 2010.*Gartner Hype Cycle 2010*. Figure.
Gartner Ltd. 20011.*Gartner Hype Cycle 2011*. Figure.
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Gartner Ltd. 2017.*Gartner Hype Cycle 2017*. Figure.
Gartner´s 2017Hype Cycle for Emerging Technologies. STAMFORD, July 2017, Gartner Ltd.
Gartner´s 2017 *Hype Cycle for Emerging Technologies: The Top Key Trends for year 2017*. STAMFORD, August 2017. https://www.gartner.com/smarterwithgartner/top-trends-in-the-gartner-hype-cycle-for-emerging-technologies-2017/

[9]. Hanel. P.,2006. Intellectual property rights business management practices: A survey of the literature, *Technovation*26(8):895-931.

[10]. Hannah L.; Kay J.A. 1977.*Concentration in Modern Industry: Theory, Measurement and the U.K. Experience.* London, Macmillan.

[11]. Herfindahl,O.C. 1950.*National Power and the Structure of Foreign Trade*. University of California. Berkley.

[12]. Hidalgo, A.; Gabaly, S. 2013. Optimization of prediction methods for patents and trademarks in Spain through the use of exogenous variables. *World Patent Information* 35: 130–140.

[13]. Hirschman, A.O. 1964. The paternity of an index. *American Economic Review* September 1964, 54: 761-762.

[14]. Hoyer, S. 2011. What is the best way to explain the inverse participation ratio (related to localization theory) in layman's term? *Quora*. Read 18.6.2017. Available at: https://www.quora.com/What-is-the-best-way-to-explain-the-inverse-participation-ratio-related-to-localization-theory-in-laymans-term

[15]. Investopedia 2017. Herfindahl-Hirschman Index – HHI.*Investopedia.*Read 18.6.2017, Available at: http://www.investopedia.com/terms/h/

[16]. Jeong, Y.; Yoon,B. 2015.Development of patent roadmap based on technology roadmap by analyzing patterns of patent development. *Technovation* May–June 2015:37-52

[17]. Justice Department in the Unites States 2015. Herfindahl–Hirschman Index. Read 18.6.2017, *The United States Department of Justice.*Available at: https://www.justice.gov/atr/herfindahl-hirschman-index

[18]. Kaivo-oja, J. 2011.*Futures of Innovation Systems and Systemic Innovation Systems: Towards Better Innovation Quality with New Innovation Management Tools*. FFRC e-Book 8/2011. Finland Futures Research Centre. University of Turku. Turku.

[19]. Kaivo-oja, J. 2016. Benchmarking analysis of patent and trademark applications in the European Union: Comprehensive innovation policy evaluation for years 1960-2013. *European Integration Studies* 10: 169-190.

[20]. Kaivo-oja, J.;Santonen, T. 2016.Futures of innovation systems and innovation management. Open innovation paradigm analysed from futures perspective. Chapter 6. In Mention, Anne-Laure & Torkkeli, Marko (2015) *Open Innovation: Bridging Theory and Practice*. Vol. 1. World Scientific, USA: 111–158.

[21]. Kaivo-oja, J.; Lauraeus, T. 2017a.Corporate knowledge management, foresight tools, primary economically affecting disruptive technologies, corporate technological foresight challenges 2008–2016, and the most important technology trends for year 2017. In Lorna Uden, Wei Lu, I-Hsien Ting (Eds.) *Knowledge Management in Organizations. 12th International Conference, KMO 2017*, Beijing, China, August 21-24, 2017, Proceedings. Communications in Computer and Information Science book series (CCIS, volume 731), Springer International Publishing AG, Cham, Switzerland: 239-253.Web: https://link.springer.com/chap…/10.1007/978-3-319-62698-7_21

[22]. Kaivo-oja, J.; Lauraeus, T. 2017b.Emerging trends and structural changes of global innovation ecosystems: Empirical analysis of changing patent and trademark activity of G7countries and BRICS countries from years 1985-2015. *Eurasian Academy of Sciences. Eurasian Business & Economics Journal* 11: 33-44.

[23]. Kaivo-oja, J.; Lauraeus, T.2017c.Benefitting from innovations and paying for innovations: The global trade of intellectual property rights: A long-run empirical analysis of receipts and payments of the use of intellectual property in G7 and BRICS countries *Eurasian Academy of Sciences.Eurasian Business & Economics Journal* 11: 45- 54.

[24]. Kuhlmann, S. 2001. Future governance of innovation policy in Europe – three scenarios. *Research Policy* 30: 953–976.

[25]. Lee, C.; Kim, J.; Kwon, O.; Woo, H–G. 2016. Stochastic technology life cycle analysis using multiple patent indicators. *Technological Forecasting and Social Change* 106: 53–64.

[26]. Lowenstein, R. 2004. *Origins of the Crash: The Great Bubble and Its Undoing.* Penguin Books, New York.

[27]. McClure, D.M. 1996. Trademarks and competition: The recent history. *Law and Contemporary Problems* 59(2), the Lanham Act after Fifty Years, Spring, 1996: 13-43.

[28]. McKinsey Global Institute (2013). *Disruptive Technologies: Advances That Will Transform Life, Business, and the Global Economy*. McKinsey & Company 2013.

[29]. Mendonca, S.; Pereira, T.S; Godinho, M.M. 2004. Trademarks as an indicator of innovation and industrial change, *Research Policy* 33(9): 1385-1404.

[30]. Porter, M. 1980. *Competitive Strategy: Techniques for Analyzing Companies and Competitors*. The Free Press, New York:49–67.

[31]. Rhoades. S.A. 1993. The Herfindahl-Hirchman Index, *Federal Reserve Bulletin*, March 1993:188-189.

[32]. Roper, S.; Hewitt–Dundas, N. 2015.Knowledge stocks, knowledge flows and innovation: Evidencefrom matched patents and innovation panel data. *Research Policy* 44: 1327–1340.

[33]. Roth, S.; Melkonyan, A.; Kaivo-oja, J.; Dana, L.-P. 2017. Interfunctional business models. Map grid for an uncharted quadrant of the Blue Ocean. *International Journal of Entrepreneurial Venturing.* Accepted. Forthcoming.DOI: 10.1504/IJEV.2017.10006709.

[34]. Sandner P.; Block J., 2011. The market value of R&D, patents, and trademarks, *Research Policy* 40(7): 969-985.

[35]. Simpson, E.H. (1949) Measurement of diversity. *Nature* 163, 688.

[36]. Tong, X.; Frame, J.D. 1994. Measuring national technological performance with patent claims data. *Research Policy* 23(2): 133–141.

[37]. Trott, P.; Hartmann, D.; van der Duinn, P.; Scholten, V.; Ortt, R. 2016.*Managing Technology Entrepreneurship and Innovation.* Routledge. London and New York.

[38]. WIPO (2016) *Understanding Copyright and Related Rights. WIPO.* Read 18.6.2017. Available at http://www.wipo.int/edocs/pubdocs/en/wipo_pub_909_2016.pdf

[39]. WIPO (2017) *Summary of the Paris Convention for the Protection of Industrial Property (1883).* Read 18.6.2017. Available at http://www.wipo.int/treaties/en/ip/paris/summary_paris.html

[40]. Woo S;Jang P;Kim Y, 2015. Effects of intellectual property rights and patented knowledge in innovation and industry value added: A multinational empirical analysis of different industries, *Technovation*43–44,September–October 2015:49-63